



UNITED STATES PATENT OFFICE

2,292,387

SECRET COMMUNICATION SYSTEM

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Anthell, Manhattan Beach, Calif.

Application June 10, 1941, Serial No. 397,412

6 Claims. (Cl. 250—2)

This invention relates broadly to secret communication systems involving the use of carrier waves of different frequencies, and is especially useful in the remote control of dirigible craft, such as torpedoes.

An object of the invention is to provide a method of secret communication which is relatively simple and reliable in operation, but at the same time is difficult to discover or decipher.

Briefly, our system as adapted for radio control of a remote craft, employs a pair of synchronous records, one at the transmitting station and one at the receiving station, which change the tuning of the transmitting and receiving apparatus from time to time, so that without knowledge of the records an enemy would be unable to determine at what frequency a controlling impulse would be sent. Furthermore, we contemplate employing records of the type used for many years in player pianos, and which consist of long rolls of paper having perforations variously positioned in a plurality of longitudinal rows along the records. In a conventional player piano record there may be 88 rows of perforations, and in our system such a record would permit the use of 88 different carrier frequencies, from one to another of which both the transmitting and receiving station would be changed at intervals. Furthermore, records of the type described can be made of substantial length and may be driven slow or fast. This makes it possible for a pair of records, one at the transmitting station and one at the receiving station, to run for a length of time ample for the remote control of a device such as a torpedo.

The two records may be synchronized by driv-

Fig. 2 is a schematic diagram of the apparatus at a receiving station;

Fig. 3 is a schematic diagram illustrating a starting circuit for starting the motors at the transmitting and receiving stations simultaneously;

Fig. 4 is a plan view of a section of a record strip that may be employed;

Fig. 5 is a detail cross section through a record-responsive switching mechanism employed in the invention;

Fig. 6 is a sectional view at right angles to the view of Fig. 5 and taken substantially in the plane VI—VI of Fig. 5, but showing the record strip in a different longitudinal position; and

Fig. 7 is a diagram in plan illustrating how the course of a torpedo may be changed in accordance with the invention.

Referring first to Fig. 7, there is disclosed a mother ship 10 which at the beginning of operations occupies the position 10a and at the end of the operations occupies the position 10b. This mother ship discharges a torpedo 11 that travels successively along different paths 12, 13, 14, 15 and 16 to strike an enemy ship 17, which initially occupies the position 17a but which has moved into the position 17b at the time it is struck by the torpedo 11. According to its original course, the enemy ship 17 would have reached the position 17c, but it changed its course following the firing of the torpedo, in an attempt to evade the torpedo.

In accordance with the present invention, the torpedo 11 can be steered from the mother ship 10a and its course changed from time to time as necessary to cause it to strike its target. In

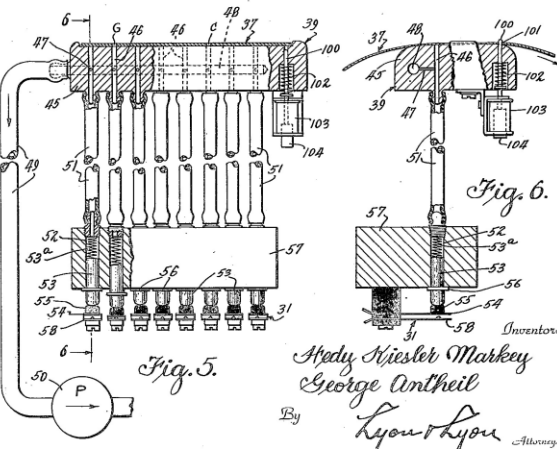
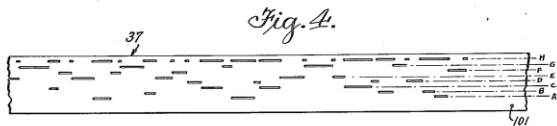
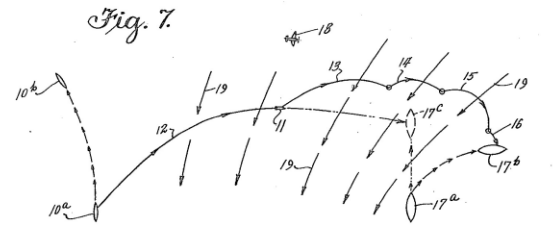


Although Lamarr had no formal training and was primarily self-taught, she invested her spare time, including on set between takes, in designing and drafting inventions, which included an improved traffic stoplight and a tablet that would dissolve in water to create a flavored carbonated drink.

During the late 1930s, Lamarr attended arms deals with her then-husband arms dealer Fritz Mandl, "possibly to improve his chances of making a sale". From the meetings, she learned that navies needed "a way to guide a torpedo as it raced through the water." Radio control had been proposed. However, an enemy might be able to jam such a torpedo's guidance system and set it off course. When later discussing this with a new friend, composer and pianist George Antheil, her idea to prevent jamming by frequency hopping met Antheil's previous work in music. In that earlier work, Antheil attempted synchronizing note-hopping in an avant-garde piece involving multiple synchronized player pianos. Antheil's idea in the piece was to synchronize the start time of identical player pianos with identical player piano rolls, so the pianos would be playing in time with one another. Together, they realized that radio frequencies could be changed similarly, using the same kind of mechanism, but miniaturized.

Based on the strength of the initial submission of their ideas to the National Inventors Council (NIC) in late December 1940, in early 1941 the NIC introduced Antheil to Samuel Stuart Mackeown, Professor of Electrical Engineering at Caltech, to consult on the electrical systems. Lamarr hired the legal firm of Lyon & Lyon to draft the application for the patent which was granted as U.S. patent 2,292,387 on August 11, 1942, under her legal name Hedy Kiesler Markey. The invention was proposed to the Navy, who rejected it on the basis that it would be too large to fit in a torpedo, and Lamarr and Antheil, shunned by the Navy, pursued their invention no further. It was suggested that Lamarr invest her time and attention to selling war bonds since she was a celebrity.

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SECRET COMMUNICATION SYSTEM
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Hedy Lamarr
born Hedwig Eva Maria Kiesler

Frequency-hopping spread spectrum

Frequency-hopping spread spectrum (FHSS) is a method of transmitting radio signals by rapidly changing the carrier frequency among many frequencies occupying a large spectral band. The changes are controlled by a code known to both transmitter and receiver. FHSS is used to avoid interference, to prevent eavesdropping, and to enable code-division multiple access (CDMA) communications.

The frequency band is divided into smaller sub-bands. Signals rapidly change ("hop") their carrier frequencies among the center frequencies of these sub-bands in a determined order. Interference at a specific frequency will affect the signal only during a short interval.

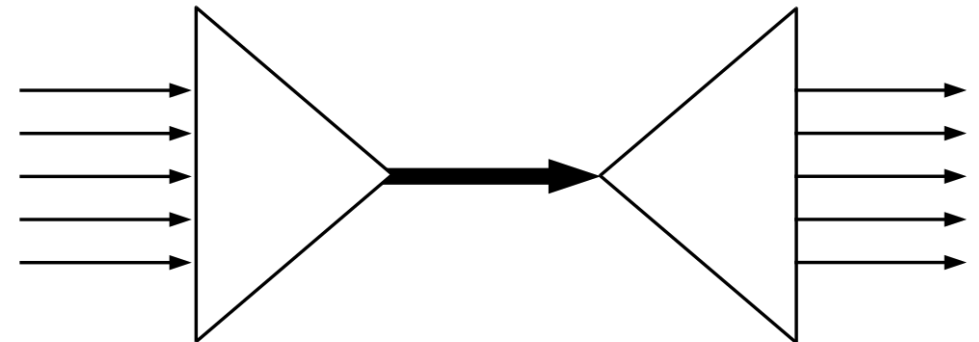
FHSS offers four main advantages over a fixed-frequency transmission:

FHSS signals are highly resistant to narrowband interference because the signal hops to a different frequency band.

Signals are difficult to intercept if the frequency-hopping pattern is not known.

Jamming is also difficult if the pattern is unknown; the signal can be jammed only for a single hopping period if the spreading sequence is unknown.

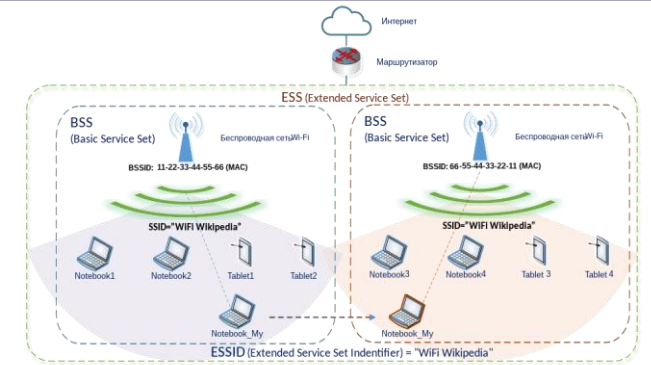
FHSS transmissions can share a frequency band with many types of conventional transmissions with minimal mutual interference. FHSS signals add minimal interference to narrowband communications, and vice versa.



Wi-Fi (/ˈwaɪfaɪ/) is a family of wireless network protocols based on the IEEE 802.11 family of standards, which are commonly used for local area networking of devices and Internet access, allowing nearby digital devices to exchange data by radio waves. These are the most widely used computer networks, used globally in home and small office networks to link devices and to provide Internet access with wireless routers and wireless access points in public places such as coffee shops, hotels, libraries, and airports to provide visitors.

Wi-Fi is a trademark of the Wi-Fi Alliance, which restricts the use of the term "Wi-Fi Certified" to products that successfully complete interoperability certification testing. Non-compliant hardware is simply referred to as WLAN, and it may or may not work with "Wi-Fi Certified" devices. As of 2017, the Wi-Fi Alliance consisted of more than 800 companies from around the world. As of 2019, over 3.05 billion Wi-Fi-enabled devices are shipped globally each year.

Wi-Fi uses multiple parts of the IEEE 802 protocol family and is designed to work seamlessly with its wired sibling, Ethernet. Compatible devices can network through wireless access points with each other as well as with wired devices and the Internet. Different versions of Wi-Fi are specified by various IEEE 802.11 protocol standards, with different radio technologies determining radio bands, maximum ranges, and speeds that may be achieved Wi-Fi most commonly uses the 2.4 gigahertz (120 mm) UHF and 5 gigahertz (60 mm) SHF radio bands; these bands are subdivided into multiple channels. Channels can be shared between networks, but, within range, only one transmitter can transmit on a channel at a time.



Hedy Lamarr born Hedwig Eva Maria Kiesler; November 9, 1914 – January 19, 2000) was an Austrian-born American actress and inventor. After a brief early film career in Czechoslovakia, including the controversial erotic romantic drama Ecstasy (1933), she fled from her first husband, Friedrich Mandl, and secretly moved to Paris. Traveling to London, she met Louis B. Mayer, who offered her a film contract in Hollywood. Lamarr became a film star with her performance in the romantic drama Algiers (1938). She achieved further success with the Western Boom Town (1940) and the drama White Cargo (1942). Lamarr's most successful film was the religious epic Samson and Delilah (1949). She also acted on television before the release of her final film in 1958. She was honored with a star on the Hollywood Walk of Fame in 1960. At the beginning of World War II, along with George Antheil, Lamarr co-invented a radio guidance system for Allied torpedoes that used spread spectrum and frequency hopping technology to defeat the threat of radio jamming by the Axis powers, however the technology was never adopted.





As a child, Lamarr showed an interest in acting and was fascinated by theater and film. At the age of 12, she won a beauty contest in Vienna. She also began to learn about technological inventions with her father, who would take her out on walks, explaining how devices functioned. Lamarr was taking acting classes in Vienna when one day, she forged a note from her mother and went to Sascha-Film and was able to get herself hired as a script girl. While there, she was able to get a role as an extra in *Money on the Street* (1930), and then a small speaking part in *Storm in a Water Glass* (1931). In early 1933, at age 18, Lamarr was given the lead in Gustav Machatý's film *Ecstasy* (*Ekstase* in German, *Extase* in Czech). On August 10, 1933, Lamarr married Mandl at the Karlskirche. Friedrich Alexander Maria "Fritz" Mandl (9 February 1900 – 8 September 1977)

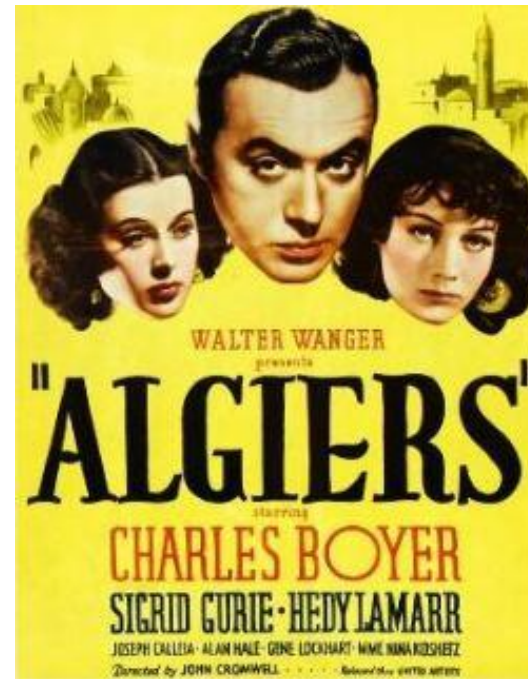
Lamarr's marriage to Mandl eventually became unbearable, and she decided to separate herself from both her husband and country in 1937. In her autobiography, she wrote that she disguised herself as her maid and fled to Paris, but by other accounts, she persuaded Mandl to let her wear all of her jewelry for a dinner party, then disappeared afterward. She writes about her marriage:

I knew very soon that I could never be an actress while I was his wife. ... He was the absolute monarch in his marriage. ... I was like a doll. I was like a thing, some object of art which had to be guarded—and imprisoned—having no mind, no life of its own.



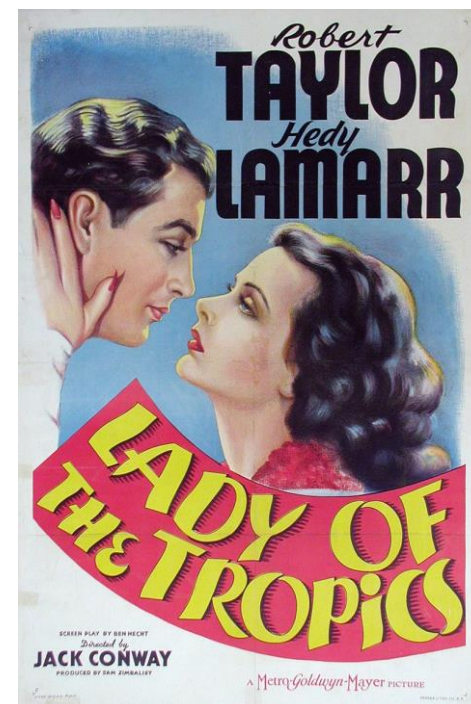
After arriving in London in 1937, she met Louis B. Mayer, head of MGM, who was scouting for talent in Europe. She initially turned down the offer he made her (of \$125 a week), but then booked herself onto the same New York bound liner as him, and managed to impress him enough to secure a \$500 a week contract. Mayer persuaded her to change her name to Hedy Lamarr (to distance herself from her real identity, and "the Ecstasy lady" reputation associated with it), choosing the surname in homage to the beautiful silent film star, Barbara La Marr, on the suggestion of his wife, who admired La Marr. He brought her to Hollywood in 1938 and began promoting her as the "world's most beautiful woman"

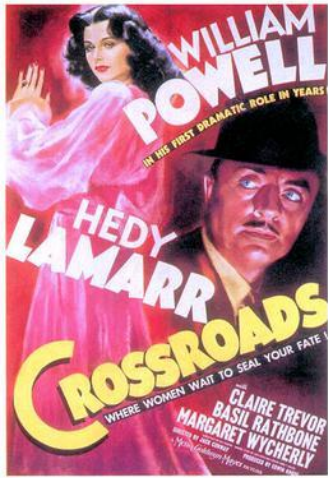
Mayer loaned Lamarr to producer Walter Wanger, who was making Algiers (1938), an American version of the French film, Pépé le Moko (1937). Lamarr was cast in the lead opposite Charles Boyer. The film created a "national sensation", says Shearer. She was billed as an unknown but well-publicized Austrian actress, which created anticipation in audiences. Mayer hoped she would become another Greta Garbo or Marlene Dietrich. According to one viewer, when her face first appeared on the screen, "everyone gasped ... Lamarr's beauty literally took one's breath away.





In future Hollywood films, she was invariably typecast as the archetypal glamorous seductress of exotic origin. Her second American film was to be *I Take This Woman*, co-starring with Spencer Tracy under the direction of regular Dietrich collaborator Josef von Sternberg. Von Sternberg was fired during the shoot, replaced by Frank Borzage. The film was put on hold, and Lamarr was put into *Lady of the Tropics* (1939), where she played a mixed-race seductress in Saigon opposite Robert Taylor. She returned to *I Take This Woman*, re-shot by W. S. Van Dyke. The resulting film was a flop.



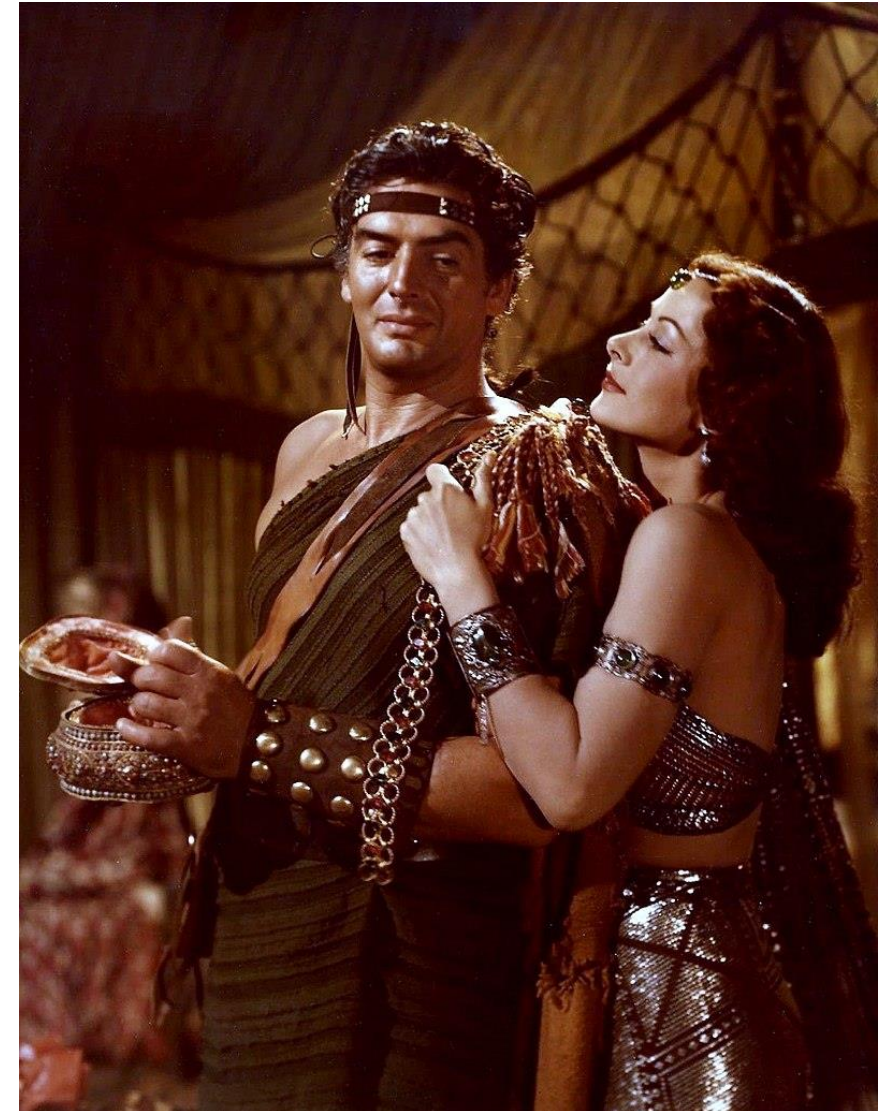


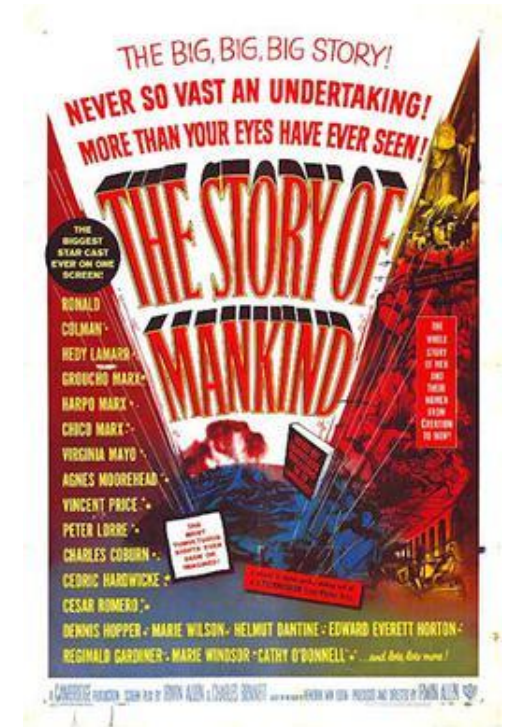
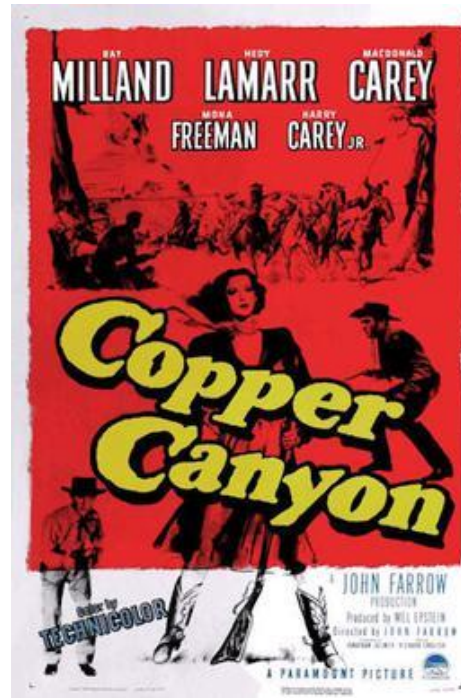
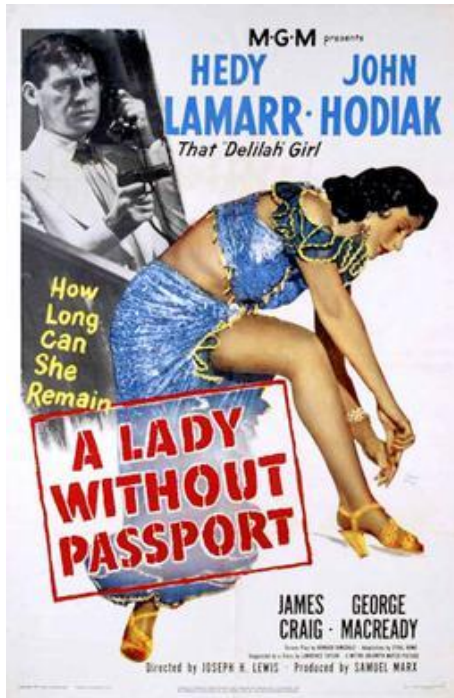
Her off-screen life and personality during those years was quite different from her screen image. She spent much of her time feeling lonely and homesick. She might swim at her agent's pool, but shunned the beaches and staring crowds. When asked for an autograph, she wondered why anyone would want it. Writer Howard Sharpe interviewed her and gave his impression:

Hedy has the most incredible personal sophistication. She knows the peculiarly European art of being womanly; she knows what men want in a beautiful woman, what attracts them, and she forces herself to be these things. She has magnetism with warmth, something that neither Dietrich nor Garbo has managed to achieve.

Lamarr wanted to join the National Inventors Council, but was reportedly told by NIC member Charles F. Kettering and others that she could better help the war effort by using her celebrity status to sell war bonds.

She participated in a war bond-selling campaign with a sailor named Eddie Rhodes. Rhodes was in the crowd at each Lamarr appearance, and she would call him up on stage. She would briefly flirt with him before asking the audience if she should give him a kiss. The crowd would say yes, to which Hedy would reply that she would if enough people bought war bonds. After enough bonds were purchased, she would kiss Rhodes and he would head back into the audience. Then they would head off to the next war bond rally.





Her career went into decline. She went to Italy to play multiple roles in Loves of Three Queens (1954), which she also produced. However she lacked the experience necessary to make a success of such an epic production, and lost millions of dollars when she was unable to secure distribution of the picture.

She played Joan of Arc in Irwin Allen's critically panned epic, The Story of Mankind (1957) and did episodes of Zane Grey Theatre ("Proud Woman") and Shower of Stars ("Cloak and Dagger"). Her last film was a thriller The Female Animal (1958). Lamarr was signed to act in the 1966 film Picture Mommy Dead, but was let go when she collapsed during filming from nervous exhaustion. She was replaced in the role of Jessica Flagmore Shelley by Zsa Zsa Gabor.

The 1970s was a decade of increasing seclusion for Lamarr. She was offered several scripts, television commercials, and stage projects, but none piqued her interest. In 1974, she filed a \$10 million lawsuit against Warner Bros., claiming that the running parody of her name ("Hedley Lamarr") in the Mel Brooks comedy *Blazing Saddles* infringed her right to privacy. Brooks said he was flattered; the studio settled out of court for an undisclosed nominal sum and an apology to Lamarr for "almost using her name". Brooks said that Lamarr "never got the joke". With her eyesight failing, Lamarr retreated from public life and settled in Miami Beach, Florida, in 1981.

Lamarr became estranged from her older son, James Lamarr Loder, when he was 12 years old. Their relationship ended abruptly, and he moved in with another family. They did not speak again for almost 50 years. Lamarr left James Loder out of her will, and he sued for control of the US\$3.3 million estate left by Lamarr in 2000. He eventually settled for US\$50,000.

In the last decades of her life, the telephone became Lamarr's only means of communication with the outside world, even with her children and close friends. She often talked up to six or seven hours a day on the phone, but she spent hardly any time with anyone in person in her final years.

Lamarr died in Casselberry, Florida, on January 19, 2000, of heart disease, aged 85. Her son Anthony Loder spread part of her ashes in Austria's Vienna Woods in accordance with her last wishes.

In 2014, a memorial to Lamarr was unveiled in Vienna's Central Cemetery, where the remainder of her ashes were buried.

Memorial to Hedy Lamarr at Vienna's Central Cemetery (Group 33G, Tomb n°80)



Marriages and children

Lamarr was married and divorced six times and had three children:

Friedrich Mandl (married 1933–1937), chairman of the Hirtenberger Patronen-Fabrik

Gene Markey (married 1939–1941), screenwriter and producer. She adopted a child (however this was later contested by the child, see below) during her marriage with Markey. Lamarr and Markey lived at 2727 Benedict Canyon Drive in Beverly Hills, California during their marriage.

John Loder (married 1943–1947), actor. The two had a daughter, Denise, who married Larry Colton, a writer and former baseball player and a son, Anthony, who worked for illustrator James McMullan. Anthony Loder was featured in the 2004 documentary film *Calling Hedy Lamarr*.

Ernest "Ted" Stauffer (married 1951–1952), nightclub owner, restaurateur, and former bandleader

W. Howard Lee (married 1953–1960), a Texas oilman (who later married film actress Gene Tierney)

Lewis J. Boies (married 1963–1965), Lamarr's divorce lawyer

Following her sixth and final divorce in 1965, Lamarr remained unmarried for the last 35 years of her life.